P01003WO2A German/Translation

Federal Republic of Germany

German Patent and Trademark Office

Preliminary published application DE 10040647 A1
International classification: B60C 23/00
File number: 10040647.5
Date of application: 19 August 2000
Date of publication: 28 February 2002
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Title:

APPARATUS AND PROCESS FOR MONITORING VEHICLE TIRES

Abstract:

The present invention concerns in particular a device on a vehicle for monitoring at least one parameter of the tires of the vehicle with a sensing device which measures at least one parameter and generates a signal value correlated with it and makes the latter available to an evaluation unit, whereupon the evaluation unit can issue warning information as a function of the signal value.

In order to be able to detect in particular a burning tire the sensory unit may display at least one gas sensor which measures the content of at least one previously specified gas in the region near the tire in question and generates a signal value correlated with it and makes it available to the evaluation unit. At this time the evaluation unit issues warning information if the gas content, or the increase in the gas content with time, exceeds a previously set limit.

Description

The invention concerns and apparatus on a vehicle for monitoring at least one parameter of the tires of a vehicle with the features of the general definition part of a claim 1. The invention also concerns a process for monitoring a parameter of the tires according to the definition part of claim 10.

From DE 4106848 A1 a process and apparatus for measuring the temperature and air pressure in a tire are known. The measured values of the temperature and air pressure in this case are transmitted by a transmitter wirelessly and processed further in a receiving circuit.

From EP 0828621 B1 an apparatus mounted on vehicles with pneumatic tires for monitoring the air pressure in the tires is known. The known device has a pressure measuring sensor for each of the tires to be monitored as well as a transmitter arranged near said pressure

measuring sensor which emits signals containing the air pressure as determined by the pressure measuring sensor. Furthermore antennas are provided for receiving these signals which are mounted on the chassis of the vehicle, one antenna being arranged near each tire, and the antennas are connected to a common electronic receiving and evaluating circuit. From the electrical conductors which lead from the antennas to the receiving circuit, in each case a branch line departs in which a rectifier is present and leads to an evaluation circuit designed as a microcomputer. In this evaluation circuit rectified signals are modulated in such a way that every time a signal emitted by the transmitter on the tire is received by one of the antennas the microcomputer evaluates only this signal transmitted via the corresponding conductor to the receiving circuit. With this design an unequivocal evaluation of the signal is made possible.

From DE 19744611 A1 a tire sensor is known which measures the spring action of the tire by measuring the distance between the rim and the inner wall of the tire on the footprint inside the tire. This tire sensor is installed inside the tire on the rim for this purpose and forms a contactlessly operating distance sensor. This distance sensor is preferably an ultrasonic echo locator [depth finder] with the aid of which the distance to the inner wall of the tread is measured. If the distances measured by the sensor are evaluated as a function of the tire rotation speed, for example, the temperature and pressure of the air contained in the tire can be determined.

From DE 19823646 A1 a process for measuring the temperature rise of a pneumatic tire is known. By monitoring the temperature rise indirectly the condition of the tire, especially the tire pressure, can be monitored. For this purpose the temperature variation measured as a function of time is compared with a typical temperature profile for the tire in question. When the measured time-dependent temperature profile exceeds a permissible standard temperature profile, warning information is emitted.

In vehicles equipped with pneumatic tires the monitoring of one parameter such as tire temperature or tire pressure is especially important. In particular in the case of utility vehicles such as buses or trucks, for example, a too low tire pressure on long trips may lead to a critical temperature rise in the tire in question. In the extreme case the tire may catch fire and burn. If this is noticed by the driver too late this may have the result that the entire vehicle will burn. Devices and processes for monitoring tires are therefore intended to contribute to reducing such risks.

The present invention deals with the problems of devising a device and a process of the type mentioned initially which improves the recognition of a critical state of a tire.

This problem is solved according to the invention by a device with the features of claim 1.

The invention is based on the general idea of coordinating a gas sensor with the tire to be monitored, which measures the content or concentration of at least one specific gas in the region near the tire in question. This gas sensor preferably monitors the concentration of a gas that is

measuring sensor which emits signals containing the air pressure as determined by the pressure measuring sensor. Furthermore antennas are provided for receiving these signals which are mounted on the chassis of the vehicle, one antenna being arranged near each tire, and the antennas are connected to a common electronic receiving and evaluating circuit. From the electrical conductors which lead from the antennas to the receiving circuit, in each case a branch line departs in which a rectifier is present and leads to an evaluation circuit designed as a microcomputer. In this evaluation circuit rectified signals are modulated in such a way that every time a signal emitted by the transmitter on the tire is received by one of the antennas the microcomputer evaluates only this signal transmitted via the corresponding conductor to the receiving circuit. With this design an unequivocal evaluation of the signal is made possible.

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typically liberated when a tire burns. Advantageously this gas sensor is designed in such a way that it senses the concentration of several gases that are liberated when a tire is burning.

By monitoring the gas concentration in the region near the tire a tire fire can be recognized directly. By means of a corresponding warning notice the driver of the vehicle can then initiate timely countermeasures.

In a preferred variant the evaluation unit may be coupled to an engine control device of the vehicle, said engine control device reducing the power of the vehicle engine as a function of the warning information from the evaluation unit. In this way the vehicle driver will receive additional information regarding the presence of a fire.

According to a special variant the gas sensor may be installed in a sensor housing which contains a gas inlet opening through which the gas to be monitored can enter the sensor housing, in which case a labyrinthine gas path is formed in the sensor housing connecting the gas inlet opening to the gas sensor. The sensor housing thus constructed prevents the fouling of the gas sensor even when the sensor housing is in the immediate proximity of the tire being monitored, e.g., in the wheel box or fender. The labyrinthine gas pathway in this case prevents dirt from getting into the gas sensor, e.g. splashed water.

In an improved variant the sensor housing may contain at least one water outlet opening in a low position on the gas pathway. By this construction the splash water penetrating into the sensor housing during driving operation through the gas inlet opening or condensate precipitated in the gas pathway can escape from the sensor housing so that the gas sensor does not malfunction.

In another variant in addition a temperature sensor may be arranged in the sensor housing to measure the temperature of the tire in question by optical scanning, in which case a rectilinear optical pathway is formed in the sensor housing through which the temperature sensor can optically scan the tire in question. By this construction the temperature sensor is also protected against splash water and other forms of pollution.

According to another variant the gas sensor and the temperature sensor at the end of the gas pathway may be arranged in the sensor housing at the end of the gas pathway, in which case the optical pathway passes through the gas pathway and the gas inlet opening. In particular, the wall segments bounding the gas path in the region of the optical path may display recesses or interruptions or be designed to be permeable for the radiation scanned by the temperature sensor. By these measures the optical path of the temperature sensor is integrated in the gas path of the gas sensor so that the sensor housing may have a relatively simple structure.

The problem which the invention addresses is solved by a process with the features of claim 10.

The invention is based on the general idea of verifying the signal value generated by a sensor in terms of its plausibility by comparing this signal with the average value of the signals from the other sensors. This procedure is based on the assumption that in normal driving operation all tires will display approximately same value for the parameter to be tested. For example, all tires have approximately the same temperature. By this procedure one can distinguish whether the temperature of all tires rises during driving operation or whether it only rises excessively on one tire. In this way predictions of critical situations can be improved.

Other important features and advantages of the invention may be derived from the sub-claims, from the drawings and from the corresponding description of the figures with reference to the drawings.

It is to be understood that the above-mentioned and yet to be explained features are applicable not only in the combinations reported in each case but also in other combinations or alone without departing the scope of the present invention.

A preferred example of embodiment of the invention is shown in the drawings and is explained in more detail in the following description.

They show, schematically in each case:

Figure 1: a side view of a segment of a vehicle equipped with a device according to the invention,

Figure 2: a sectional view through the sensor housing according to the invention, and

Figure 3 a schematic view of the device according to the invention.

Corresponding to Figure 1, the vehicle not otherwise shown, e.g., a truck, has two rear axles 1 and 2 on which at least one tire 3 is mounted on each side of the vehicle. A wheel box [fender] 4 encloses the tire 3 in each case at least up to the structure 5 of the vehicle.

In the wheel box 4 for each tire 3 a sensor housing 6 is installed which contains, e.g., a gas sensor not recognizable in Figure 1 as well as an also not shown temperature sensor. The temperature sensor optically scans the tire 3 in order to measure the temperature of the tire 3 in question, the beam path required for this being denoted by 7 in Figure 1.

According to Figure 2 the sensor housing 6 in a special variant may display a capsuled structure which is especially sealed against dirty water. A housing wall facing the viewer is omitted for better representation of the sensor housing 6 in Figure 2. The sensor housing 6 on an end side facing the tire 3 in question displays a gas inlet opening 8 through which a gas to be monitored can penetrate from the region 9 surrounding the tire 3 into the sensor housing 6. In the interior of the sensor housing 6 a labyrinthine gas path 10 is formed so that there is no

rectilinear direct connection between the gas inlet opening 8 and gas sensor 11 arranged at one of the ends of the gas path 10 facing away from the gas inlet opening 8 or in the sensor housing 6. In this way a fouling of the gas sensor 11, e.g., by splashed water can be avoided.

The labyrinthine flow path 10 inside the sensor housing 6 is formed by wall segments 12 which bound the gas path 10 protruding from the sidewalls 13 of the sensor housing 6 vertically into the interior of the sensor housing 6. Inside the gas path 10 at places which are relatively low in the installed position of the sensor housing 6 water outlet openings 14 are formed on the sensor housing 6. As figure 2 shows outflow connecting pipes 15 are connected to these water outlet openings 14. Moisture condensing in the interior of the sensor housing 6 or splash water penetrating through the gas inlet opening 8 to the interior of the sensor housing 6 collects in the low-lying places and from there can flow through the water outlet opening 14 out of the sensor housing 6.

Besides the gas sensor 11 also at the end of the gas path 10 a temperature sensor 16 is arranged on or in the sensor housing 6. By this arrangement also the temperature sensor 16 is protected against contamination, e.g. by splash water. This temperature sensor 16 which is designed, e.g., as a pyrometer, operates by optical scanning, in which case a certain radiation must come from the tire 3 being scanned to the temperature sensor 16. Since such radiation usually propagates in a straight line, a rectilinear optical path 17 is formed for the temperature sensor 16 in the interior of the sensor housing 6 through which the temperature sensor 16 can optically scan the tire 3 in question. As Figure 2 shows this optical pathway 17 is arranged in this case in such a way that it passes through the gas path 10 and also through the gas inlet opening 8 inside the sensor housing 6.

In this case recesses or interruptions or windows 18 are formed in the wall segments 12 which are permeable for the radiation scanned by the temperature sensor 16.

Figure 3 shows a schematic representation of a simple arrangement of the device according to the invention. In this variant, for example, a vehicle having a front axle, rear axle and four wheels and tires is equipped with the device according to the invention. The subscript "VL" in this case denotes the left front tire, the subscript "VR" the right front tire, the subscript "HL" the left rear and "HR" the right rear tire.

In the arrangement shown in Figure 3 therefore a gas sensor 11 and a temperature sensor 16 are assigned to each of the four tires. All gas sensors 11 are connected by corresponding signal conductors 19 to a first evaluation unit 20 which serves to evaluate the signals of the gas sensors 11. Correspondingly all temperature sensors 16 are connected by suitable signal conductors 21 to a second evaluation unit 22 serving to evaluate the signals of the temperature sensors 16. In a preferred variant the two evaluation units 20 and 22 can communicate with each other, as indicated by the double arrow 23. By this coupling of the two evaluation unit 20, 22, for example, plausibility tests can be performed to ascertain whether, for example, a temperature

increase on one tire, coincides with an increase in the combustion gas concentration in the vicinity of said tire.

Instead of two separate evaluation units 20, 22 also a common evaluation unit may be provided connected to the signal conductors 19 and 21.

The two evaluation units 20 and 22 in each case are connected by a signal conductors 24 and 25 respectively to a signaling device 26 which may be arranged, e.g., in the driver's compartment of the vehicle. This signaling device 26 has an indicator unit or display 27 with control lights 28, each of which is coordinated with one of the tires and coordinated with control light 29 for each of the parameters been monitored, i.e. on the one hand gas concentration (gas) and on the other temperature (temp). For example, if an elevated temperature is found on the left front tire, on the display 27, on the one hand, the control light assigned to the left front tire 28 and on the other the control lights 29 assigned to the temperature monitoring light up.

In a special variant the apparatus according to the invention shown in Figure 3 operates as follows:

The sensors 11 and 16 continually measure the temperature of the tire tread and the concentration of one or more of certain combustion gases in the vicinity of the tire. The term "combustion gases" in this case means gases that are liberated when a tire is burning. The sensors 11 and 16, as a function of the measurements, generate signals which correlate with the measured temperatures or gas concentrations. These signals are then passed via signal conductors 19, 21 to the evaluation units 20 and 22 respectively.

The evaluation units 20 and 22 check whether the measured signal values and/or their increase with time lie below preassigned maximally permissible limits. As soon as an impermissibly high signal value and/or an impermissibly strong signal value increase is recognized, the indicator unit 20, 22 generates a corresponding warning and passes it through signal conductor 24 and 25 to the signaling device 26. The corresponding control lights 28, 29 on the display 27 are then actuated.

The evaluation units 20 and 22 also perform another query operation which checks for each measurement time whether the corresponding signal value for each monitored tire deviates from the mean value of the signals of all other monitored tires for this measurement time.and whether this deviation still lies within a preassigned tolerance range. This special query routine is performed separately for the signal values of the temperature measurement and for the signal values of the gas concentration measurement. The measurement is performed for each tire separately. If, for example, it is determined that the temperature of the right rear tire deviates too strongly from the mean value of the temperatures of the other tires, the second evaluation unit 22 generates a corresponding warning. This warning can be emitted especially already before the right rear tire has reached the maximally permissible temperature. By this procedure and impermissible temperature increase of a tire can already be recognized a very early point in time.

Claims

1. Device on a vehicle for monitoring at least one parameter of the tires (3) of a vehicle with a sensor system (11, 16) which measures at least one parameter and generates a signal value correlated with it and makes it available to an evaluation unit (20, 22), whereupon the evaluation unit (20, 22) can emit warning information as a function of the signal value, characterized by the fact that the sensor systems displays at least one gas sensor (11) which measures the content of at least one previously specified gas in the region (9) surrounding the tire (3) in question and generates a signal value correlated with it and makes it available to the evaluation unit (20), whereupon the evaluation unit (20) emits warning information when the gas content or when the chronological increase in the gas content exceeds a preassigned limit.

2. Device as in claim 1, characterized by the fact that the gas sensor (11) senses at least one gas which is formed when a tire (3) is burning.

3. Device as in claims 1 or 2, characterized by the fact that the evaluation unit (20) is coupled to an engine control device of the vehicle, said engine control device reducing the power of the vehicle engine as a function of the warning information from the evaluation unit (20).

4. Device as one of claims 1-3, characterized by the fact that the sensory system also displays a temperature sensor (16), e.g. a pyrometer which measures the temperature of the tire (3) in question by optical scanning and generates a signal value correlated with it and makes it available to an evaluation unit (22), whereupon the evaluation unit (22) emits warning information when the temperature or when the chronological increase in temperature exceeds a predetermined limit.

5. Device as one of claims 1-4, characterized by the fact that the gas sensor (11) is installed in a sensor housing (6) which contains a gas inlet opening (8) through which the gas to be monitored can enter the sensor housing (6), a labyrinthine gas path (10) having been formed in the sensor housing (6) connecting the gas inlet opening (8) to the gas sensor (11).

6. Device as in claim 5, characterized by the fact that the sensor housing (6) contains at least one water outlet opening (14) located in a low part of the gas path (10).

7. Device as in at least claims 4 and 5, characterized by the fact that the temperature sensor (16) is arranged in the sensor housing (6), while in the sensor housing (6) a rectilinear optical path (17) is formed through which the temperature sensor (16) can optically scan the tire (3) in question.

8. Device as in claim 7, characterized by the fact that the gas sensor (11) and the temperature sensor (16) are arranged at the end of the gas path (10) in the sensor housing (6), the optical path (17) passing through the gas pathway (10) and the gas inlet opening (8).

9. Device as in claim 8, characterized by the fact that the wall segments (12) bounding the gas path (10) in the region of the optical path (17) display recesses or interruptions (18) or are designed to be permeable for the radiation scanned by the temperature sensor (16).

10. Process for monitoring a parameter of a tire (3) of a vehicle, characterized by the fact that for each of several tires (3) a sensor (11, 16) is provided which measures the parameter of the corresponding tire (3) and generates a signal value correlated with it and makes said signal value available to an evaluation units (20, 22), that the evaluation unit (20, 22) emits warning information if at a time of measurement the signal value of a tire (3) deviates by a predetermined tolerance limit from the mean value of the signals from the other tires (3).

11. Process as in claim 10, characterized by the fact that the indicator unit (20, 22) generates the warning information as a function of which of the signal values causes the warning information to be emitted so that the driver of the vehicle can recognize which tire (3) has an impermissible parameter.

12. Process as claims 10 or 11, characterized by the fact that the parameter is the tire temperature or the tire pressure or the gas content of at least one specific gas in the region around the tire (3).

Two pages of drawings appended